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Work-related and psychological determinants of multisite musculoskeletal pain

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Objective Musculoskeletal pain is associated with occupational physical activities and psychosocial risk factors. We evaluated the relative importance of work-related and psychological determinants of the number of anatomical sites affected by musculoskeletal pain in a cross-sectional survey.

Methods The survey focused on musculoskeletal pain in six body regions (low-back, neck, shoulder, elbow, wrist–hand, and knee) among 224 nurses, 200 office workers and 140 postal clerks in Crete, Greece (response rate 95%). Information was collected about demographic characteristics, occupational physical load, psychosocial aspects of work, perceptions about the causes of pain, mental health, somatization, and experience of pain in the past 12 months. We used Poisson regression to assess associations of risk factors with the number of painful anatomical sites and explored interactions using classification and regression trees (CART).

Results Two-thirds of the study sample reported pain in ≥2 body sites during the past 12 months, and in 23%, >3 sites were affected. The number of painful anatomical sites was strongly related to both physical load at work and somatization (with relative risks increased 5-fold or more for frequent and disabling multisite pain) and was also significantly associated with work-related psychosocial factors and beliefs about work causation. The CART analysis suggested that somatization was the leading determinant of the number of painful body sites.

Conclusion In the population studied, pain at multiple anatomical sites was common and strongly associated with somatization, which may have a more important influence on multisite pain than pain that is limited to a single anatomical site.

Key terms epidemiology; musculoskeletal disorder; MSD; occupational health.

Musculoskeletal pain is a leading cause of disability among people of working age in Europe and has a substantial social and economic impact (1). Much effort has gone into investigating its causes and prevention, but several aspects of the problem still require clarification.

A number of critical literature reviews have provided evidence that psychosocial workplace factors correlate with occupational musculoskeletal disorders (2–4), and a number of studies also suggest that individual psychological factors relate to consultation for and disability from musculoskeletal disorders (5–8). One important area of uncertainty is the extent to which psychological factors influence musculoskeletal illness and associated disability. Marked variations have been reported between workers doing similar jobs in dissimilar settings (9, 10). In two large community-based surveys, with subjects drawn from various countries, striking differences were reported in the prevalence of chronic back pain and chronic persistent regional pain – too large to be explained simply by differences in occupational physical workload (11, 12).

Such observations suggest that mechanical overload is perhaps not the leading cause of regional musculoskeletal pain. Prevention may require multifaceted

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interventions aimed at addressing other factors, such as health beliefs, coping styles and mental ill health, as well as reducing the effort of work (13). In planning interventions, it would be helpful to establish with greater certainty the relative importance of occupational and non-occupational risk factors in the causation of common musculoskeletal symptoms and associated disability. Moreover, this research should cover non-occupational risk factors such as somatization (ie, the tendency to complain persistently of physical symptoms that have no identifiable medical explanation), which have been less commonly studied in the workplace but strongly associated with musculoskeletal disability in the wider community (5, 6).

A further question is whether the relative importance of risk factors differs for pain occurring at multiple sites. In the general population, widespread pain is common (14), its extent varying across a biological continuum (15, 16). It has a substantial impact on physical fitness, general health status and wellbeing, activities of daily living, and psychological distress (15, 17–20), and, among workers, it may predict future risk of long-term sickness absence (21, 22). But in most occupational investigations, musculoskeletal pain has been studied only in specific anatomical sites (23–25), assuming a model in which local physical stressors generate local mechanical problems. Widespread pain has been studied less often, usually as a confounder (26, 27) or prognostic indicator (28) but rarely as a primary health outcome (29). Evidence from studies in the general population suggests that non-occupational risk factors, such as low mood and high health anxiety, associate prominently with generalized pain (14, 30, 31), but relatively little is known about the determinants of widespread pain in the workplace (32). Furthermore, although widespread pain occurs on a continuum of severity, most epidemiological studies, including those carried out in occupational settings, have applied a pre-specified dichotomous case definition. Therefore, it may be more informative to assess risks according to the number of regional sites with pain.

In this study, we (i) assessed the prevalence of regional musculoskeletal pain in three occupational groups in Greece [a country which, according to one WHO study, lies in the lowest quintile for primary care attendance for musculoskeletal pain (12)]; (ii) determined the frequency of individual and work-related risk factors for pain at multiple anatomical sites; and (iii) undertook a novel analysis aimed at assessing the relative importance of occupational and non-occupational risk factors in determining the number of regional anatomical sites reported as painful. Data were collected as part of an international multicentre collaborative investigation, designed to explore cultural and psychosocial influences on musculoskeletal symptoms and disability (the CUPID study).

Methods

Population and questionnaires

We conducted a cross-sectional survey in Crete, Greece during June to December 2006. The study sample comprised a random subset of nurses (N=240) from the staff of Heraklion University Hospital, all office workers (N=202) employed at Heraklion University who were registered as computer users, and all postal clerks (N=154) from the central postal offices of the four prefectures of Crete. To be included, subjects had to be aged 21–60 years and have worked for ≥1 year in their current job. The Scientific Board Committee of the University Hospital of Heraklion approved the study protocol. Written informed consent was obtained from all participants.

We evaluated an integrated multifactorial model for musculoskeletal pain incorporating both work-related and psychological determinants. We collected information from participants via personal interviews at their place of work, using a structured questionnaire that covered demographic characteristics, physical and psychosocial risk factors at work, mental health (low mood), somatization, alexithymia, depression, health beliefs, musculoskeletal pain lasting for >1 day in the past 12 months, and associated difficulty in carrying out everyday activities.

The occupational risk factors studied concerned the physical demands of work, the number of hours worked per week, and the perceived psychosocial work environment.

We classified physical demand using a score of 0–5, with a 1-unit increase for each body site reported as being strained during a typical day at work (for this purpose the neck and shoulder were treated as a single site). Body sites were regarded as being strained if positive answers were elicited to questions as follows: (i) low back – "lifting >25 kg by hand"; (ii) neck–shoulder – "working with the hands above shoulder height for ≥1 hour in total"; (iii) elbow – "repeated bending and straightening of the elbow for ≥1 hour in total"; (iv) wrist–hand – either "typing >4 hours in total" or " doing other repeated movements of the wrist or hands for >4 hours in total"; and (v) knee – either " kneeling or squatting for >1 hour in total" or "climbing >30 flights of stairs in total".

Questions on job support, control, and demand were based on the Karasek model (33), with job control classified as "high" if the respondent had discretion over what work was to be done, how, and according to what timetable; job demands were classified as "low" in the absence of any of piecework, targets, and time pressure. Questions were also asked about job satisfaction and security and support from colleagues and/or supervisor(s).

We assessed mental health using questions derived from the mental health section of the Short Form-36 questionnaire (34) and used elements of the somatic subscale of the Brief Symptom Inventory (35), to measure somatization. The inventory is a measure of distress and psychopathology, comprising items on bothersome nausea, faintness, dizziness, weakness, numbness, chest pain, and breathing difficulties in the past seven days. For mental health, we summed the scores for individual questions and the totals were classified to thirds of their distribution in the study sample. Somatization was classified according to the number of somatic symptoms (out of a total of seven) that were rated as at least moderately distressing (5). We obtained data on alexithymia (difficulty understanding and expressing one's own feelings and those of others) using the 20-item Toronto Alexithymia Scale (TAS-20) (36) and assessed depression with the Beck Depression Inventory (BDI-II) (37). For each of these two scales, we employed standardized cut-off points for the Greek population (38, 39) using Anagnostopoulou & Kiosseoglou's Greek validation of the TAS-20 (11 May 2006: unpublished manuscript).

The health beliefs that we explored related to the work-relatedness of back and upper-limb pain and how a person would react if symptomatic. Belief in work as a cause of pain was considered: (i) "strong" if the participant completely agreed that pain, both in the low back and the upper limb, was most commonly caused by work, (ii) "weak" when the perception was limited to only one of these anatomical sites, and (iii) otherwise "absent". Questions about actions in response to symptoms were modified from the Fear-Avoidance Beliefs Questionnaire (40), and answers were counted as positive if the participant completely agreed that one should avoid physical activity when in pain, and that rest was needed for recovery.

The questions on musculoskeletal symptoms were adapted from the Nordic Questionnaire on Musculoskeletal Complaints (41) and related to six anatomical sites: low back, neck, shoulder, elbow, wrist–hand, and knee.

Apart from the questions on alexithymia and depression, the questionnaire was a Greek version of the one used in the international CUPID study (9). Originally formulated in English, this was translated into Greek, back translated to English, and administered in both languages to five volunteers. Researchers in Crete, the coordinator of the international study, and the professional translator reached consensus on any identified anomalies, and the wording was revised appropriately. A complete report of the translation protocol is available (Solidaki E. Pilot study in Crete for an international survey on musculoskeletal disorders [title page and abstract in Greek but follows in English] 2006. Available from: http://mph.med.uoc.gr/files/Dissertations/2006_Solidaki.pdf).

Statistical analysis

The main outcome measures were: (i) the total number of body sites that were painful for ≥1 day in the past 12 months, (ii) the number of sites that were frequently painful in the past 12 months, and (iii) the number of sites at which pain was disabling in the past month. "Frequent" pain was defined as pain that had lasted for ≥30 days in total in the past 12 months. Pain was considered "disabling" when it had made it difficult or impossible to carry out ≥2 everyday activities in the past month from a pre-specified list (eg, household chores, getting dressed). The questions about restriction of activities were limited to a more recent time period (one month rather than one year) to achieve a more reliable recall (42).

We used Poisson regression (43, 44) to model relations between individual, physical, and psychosocial factors and the 3-count outcomes (ie, number of sites in pain, frequent pain and disabling pain). Each potential risk factor was examined one at a time, after adjusting for age, gender, and main occupation. Risk factors that were significantly associated with the outcomes under study in this analysis were subsequently introduced simultaneously in a multivariable model together with age, gender, and main occupation. Statistical significance was set at $P<0.05$. We applied Poisson regression after having set equal follow-up time for all subjects, and derived incidence rate ratios (IRR) per one year or one month incidence rates. This approach avoids problems of convergence in models examining prevalence. The percentage of change in the expected outcome count (or number of sites in pain) for the exposed compared to non-exposed category was calculated as $(100) \times (\text{IRR-1})$. We used the statistical package STATA/SE 10 (StataCorp LP, College Station, TX, USA) for the analysis.

We assessed interactions between potential determinants of the number of painful anatomical sites using classification and regression trees (CART) implemented in the R statistical software (www.r-project.org/). CART, known as binary recursive splitting, uses non-parametric methods. It produces "trees" that represent a model in which every node is determined by splitting the data set on the basis of the variable that provides the best separation. At every succeeding branch, all variables are tested again for their usefulness in further splitting. The relative importance of each variable in the final tree is assessed based on its importance over all nodes and splits (45, 46). CART's advantage over logistic regression is its ability to identify subgroups of individuals with different characteristics that are at high risk. All the potential determinants of pain that were examined in the Poisson regression analysis were included also in the CART models, and the number of painful sites was introduced as a discrete outcome variable with levels from 0–6. Cross-validation was used to reduce over-fitted trees to their optimal size by randomly splitting the data into ten equal parts and subsequently using learning (part of the data) and testing sets, respectively, to construct and validate the tree model. This cross-validation process was repeated ten times and used to estimate the classification error and the cost-complexity parameter that determined the reduction of the trees to their optimal size (45, 46).

Results

A total of 564 workers (224 nurses, 140 postal clerks and 200 office workers) took part in the study with an overall response rate of 95%. Nurses and office workers were mostly women (88% and 75% respectively), while postal workers were predominantly men (84%). Postal workers (mean age 46 years) were older on average than nurses (37 years) and office workers (40 years).

Table 1 sets out the 12- and 1-month prevalence of pain at different anatomical sites among the participants. Regional musculoskeletal pain, especially low-back and neck pain, were common among both men and women. Neck, shoulder, and wrist–hand pain were more prevalent among women than men.

Table 2 shows the frequency with which the different numbers of body sites were reported as being painful. Some 23% of the study sample reported multisite pain (>3 sites affected) in the past 12 months, but frequent pain in the past 12 months and disabling pain in the past month were less commonly multisite (4–5% of participants).

Table 3 presents the distribution of the independent variables in the study sample and their association with the outcomes under study. All IRR were adjusted for age, gender, and main occupation. Women reported a higher number of body sites in pain for all three outcomes. Further analysis, however, suggested that this difference could be attributed to the difference in somatization scores between men and women (information not shown). The number of pain sites tended to increase with age. After allowing for these factors, increasing physical load showed a strong linear association with the number of pain sites affected, especially for frequent or disabling pain (IRR 8.4 and 25.8 respectively), as did somatization (IRR raised about 5-fold for the same outcomes). Other risk factors which showed weaker but statistically significant associations with each outcome included: (i) both high job satisfaction and support (moderately protective) and (ii) strong beliefs in work as a cause of pain (positive relationship). Being in the grey zone for alexithymia (ie, intermediate scores) seemed to have a moderately protective effect against multisite and frequent multisite pain in the past 12 months; no relation was found with depression although a positive monotonic relationship was found with mental health score.

Risk factors that were significantly associated with the outcomes under study, when examined one at a time, were subsequently introduced simultaneously in a multivariable model together with age, gender, and main occupation (table 4). The corresponding IRR that were statistically significant are presented in table 4, except for age, gender, and occupation that were included in all models. Somatization was statistically significant in all three models and was very strongly associated with both disabling and frequent pain. Increasing physical load at work was also significantly associated with the three outcomes. Being in the grey zone for alexithymia significantly reduced the number of occurrences of any pain and frequent pain in the past 12 months, thus implying a U-shaped-curve-type of association. Job satisfaction and support were both present as protective factors for disabling pain in the past month, whereas strong beliefs about work as a cause of musculoskeletal pain were positively associated with any pain and frequent pain in the past 12 months.

Table 1. Twelve- and one-month prevalence for the six localizations of pain by gender

Pain site	Past 12 months				Past month			
	Men		Women		Men		Women	
	N	%	N	%	N	%	N	%
Low back	121	62	233	63	72	37	149	40
Neck	79	41	191	52	46	24	139	38
Shoulder	63	33	146	40	39	20	100	27
Elbow	39	20	73	20	23	12	42	11
Wrist–hand	47	24	165	45	30	16	97	26
Knee	48	25	96	26	37	19	66	18

Table 2. Number (and percent) of body sites in pain and frequent pain in the past 12 months and in disabling pain in the past month

Number of body sites in pain	Pain in past 12 months		Frequent pain in past 12 months		Disabling pain in past month	
	N	%	N	%	N	%
0	75	13	347	62	331	59
1	113	20	124	22	113	20
2	136	24	52	9	63	12
3	108	19	23	4	23	4
4	85	15	9	2	19	3
5	30	5	3	1	7	1
6	17	3	3	1	3	1

Table 3. Association [incidence rate ratio (IRR)] of determinants of pain with number of sites in pain and frequent pain in the past 12 months and in disabling pain the last month. All IRRs are adjusted for age, gender, and occupation. [mths = months, 95% CI= 95% confidence interval]

Characteristic	N [a]	Sites in pain past 12 mths		Sites in frequent pain past 12 mths		Sites in disabling pain past mth	
		IRR	95% CI	IRR	95% CI	IRR	95% CI
Gender							
Men	194	1.0		1.0		1.0	
Women	370	1.3	1.1–1.5	1.9	1.4–2.5	2.4	1.8–3.2
Occupation							
Nurse	224	1.0		1.0		1.0	
Post clerk	140	1.1	0.9–1.3	1.5	1.0–2.0	1.4	1.0–1.9
Office work	200	1.0	0.9–1.1	0.9	0.7–1.2	0.7	0.6–0.9
Age groups (years)							
20–29	29	1.0		1.0		1.0	
30–39	257	1.4	1.1–1.9	4.9	1.6–15.4	1.6	0.9–2.7
40–49	206	1.6	1.2–2.2	8.9	2.8–27.8	2.3	1.3–4.1
50–59	69	1.4	1.0–2.0	8.5	2.6–27.5	2.0	1.1–3.8
Work hours/week							
≤39 hours	139	1.0		1.0		1.0	
≥40 hours	423	1.1	0.9–1.3	1.1	0.9–1.5	1.4	1.1–1.8
Physical load score							
0	17	1.0		1.0		1.0	
1	71	2.5	1.4–4.6	4.0	1.0–17.0	8.8	1.2–64.9
2	169	3.4	1.9–6.1	6.1	1.5–24.9	16.4	2.3–118.1
3	151	3.4	1.9–6.0	5.3	1.3–21.5	14.5	2.0–104.1
4	111	3.9	2.2–7.0	8.9	2.2–36.2	19.5	2.7–140.0
5	45	4.7	2.6–8.4	8.4	2.0–34.7	25.8	3.6–186.5
Job satisfaction							
Low	114	1.0		1.0		1.0	
High	448	0.7	0.6–0.8	0.6	0.5–0.8	0.5	0.4–0.6
Job demand							
Low	107	1.0		1.0		1.0	
High	455	1.1	0.9–1.3	1.6	1.1–2.2	1.0	0.8–1.3
Job control							
Low	331	1.0		1.0		1.0	
High	233	1.0	0.9–1.1	0.9	0.7–1.1	0.8	0.7–1.1
Job support							
Low	101	1.0		1.0		1.0	
High	455	0.9	0.8–1.0	0.7	0.5–0.8	0.7	0.6–0.9
Job security							
Low	114	1.0		1.0		1.0	
High	448	1.0	0.9–1.1	0.9	0.7–1.2	0.9	0.7–1.1
Mental health score (tertiles)							
Best	183	1.0		1.0		1.0	
Middle	201	1.2	1.0–1.4	1.3	0.9–1.7	1.4	1.1–1.9
Worst	180	1.5	1.3–1.7	1.7	1.3–2.3	2.1	1.6–2.7
Somatizing symptoms							
0	261	1.0		1.0		1.0	
1	84	1.3	1.1–1.6	2.7	1.9–3.8	2.1	1.5–3.1
≥2	218	2.0	1.8–2.3	4.8	3.6–6.4	5.5	4.2–7.2
Alexithymia							
None	400	1.0		1.0		1.0	
Grey zone	76	0.9	0.7–1.0	0.6	0.4–0.9	0.9	0.6–1.2
Alexithymic	54	1.1	0.9–1.3	1.1	0.8–1.5	1.0	0.7–1.4
Depression							
None	368	1.0		1.0		1.0	
Mild	101	1.0	0.9–1.1	0.8	0.6–1.1	0.9	0.7–1.2
Moderate /severe	67	1.0	0.9–1.2	0.9	0.7–1.3	1.0	0.7–1.4
Fear-avoidance beliefs							
No	272	1.0		1.0		1.0	
Yes	292	1.0	0.9–1.2	1.0	0.8–1.3	1.3	1.1–1.6
Work causation beliefs							
No	168	1.0		1.0		1.0	
Weak	88	1.1	0.9–1.3	1.6	1.1–2.3	1.1	0.8–1.5
Strong	308	1.3	1.1–1.5	1.7	1.3–2.2	1.5	1.2–2.0

[a] Responses do not sum to 564 due to a few missing answers

Table 4. Multivariable model [incidence rate ratio (IRR)] for the determinants of the number of sites in pain and frequent pain in the past 12 months and disabling pain in the past month. All IRR are mutually adjusted and adjusted for age, gender, and occupation. [95% CI= 95% confidence interval]

Determinant	Pain in past 12 months		Frequent pain in past 12 months		Disabling pain in past month	
	IRR	95% CI	IRR	95% CI	IRR	95% CI
Somatizing symptoms						
0	1.0		1.0		1.0	
1	1.2	1.0–1.4	2.3	1.6–3.4	1.8	1.2–2.7
≥2	1.7	1.5–2.0	4.5	3.3–6.3	4.3	3.2–5.8
Alexithymia						
None	1.0		1.0			
Grey zone	0.8	0.7–1.0	0.6	0.4–0.9		
Alexithymic	1.1	0.9–1.3	1.0	0.7–1.3		
Job satisfaction						
Low	1.0				1.0	
High	0.9	0.8–1.0			0.7	0.6–0.9
Job support						
Low					1.0	
High					0.8	0.6–1.0
Physical load score						
0	1.0		1.0 [a]		1.0	
1	1.7	0.9–3.1	2.1	0.5–9.1	4.8	0.6–35.7
2	2.1	1.1–3.7	2.0	0.5–8.4	5.7	0.8–41.1
3	2.0	1.1–3.5	1.9	0.5–7.9	5.4	0.7–39.3
4	2.3	1.3–4.1	3.0	0.7–12.5	6.0	0.8–44.0
5	2.5	1.3–4.5	2.6	0.6–11.2	8.0	1.1–58.3
Work causation beliefs						
Weak	1.0		1.0			
Moderate	1.1	0.9–1.3	1.4	0.9–2.1		
Strong	1.2	1.0–1.4	1.4	1.0–1.9		

[a] P-value for trend= 0.05

On the following page, figure 1 shows the CART model for determinants of pain at multiple sites. The number of painful anatomical sites in the last 12 months was entered as a discrete variable with levels from 0–6. The analysis indicated an optimal tree with six splits and seven terminal nodes, in which somatization was the main variable differentiating pathways that led to a few or multiple sites of pain. For each split, the figure shows the risk factor (and its level) that discriminated between the two subsets of workers distinguished by the split, and a cut-off point in the number of sites of pain that characterized the distinction between the two subsets. The optimal tree had a relatively low sensitivity of 14% on the test sets indicating that while this analysis identifies discrete causal pathways, they explain only part of the variation in the population. Not surprisingly (on the basis of results from the multivariate analysis), the first split was based on somatization. Occupation seemed to be an important discriminant between subjects with no or only one painful site (left pathway in the figure). Subjects with high somatizing scores were further split according to age and the level of the somatizing score, distinguishing groups of subjects with pain at different numbers of multiple sites. Somatizing appeared as the main determinant in subjects with the highest number of multiple pains (right pathway in the figure), while a complex grouping of risk factors, including psychological and physical load, could be discerned for subjects with intermediate levels of somatizing scores and a number of multiple pains. The interaction between physical load and somatization was not statistically significant (likelihood ratio test, P-value for interaction=0.21).

Discussion

Regional musculoskeletal pain and pain at multiple sites were common in all three of the Greek occupational groups studied. Two-thirds of the study sample reported pain in ≥2 body sites in the past 12 months; in 23% of the sample, >3 three sites were affected. The number of painful anatomical sites was strongly related to both physical load at work and somatization, and was also significantly associated with work-related psychosocial factors, and beliefs about work causation. The CART analysis suggested that, in the population studied, somatization was the leading determinant of the number of painful body sites.

Our study had several methodological strengths. The study sample targeted was representative of the occupational groups investigated; the nurses were a random sample of nursing personnel at the University Hospital of Heraklion, while all postal clerks in Crete and all office workers at Heraklion University were invited to take part, provided they met the inclusion criteria of age and duration of employment. Moreover, a high response rate was achieved.

The Brief Symptom Inventory, on which we based our assessment of somatization, has predictive validity for incident and persistent regional pain (5, 6, 35) and correlates with disability attributed to multisite pain (47). The Short Form-36 is a well recognized and widely used standard instrument (34). We adapted the Fear-Avoidance Belief Questionnaire designed originally to assess back pain; while both the Toronto Alexithymia Scale and BDI-II have been used extensively and validated for application in the Greek population (38, 39) .

Our findings should, however, be considered in the context of several limitations of the study design. Data collection was based on interviewer-administered questionnaires, and, as in many other studies, no clinical measures of pain or disability were used. Reliance was placed on the ability and willingness of respondents to recall symptoms over a period of up to 12 months, although, reassuringly, similar associations were found for disabling pain in the past month, which should have been recalled more accurately.

In addition, the cross-sectional design of the study leaves open questions about the direction of causation for some of the associations demonstrated. For example, job satisfaction, perception of support in the workplace, and beliefs about work as a cause of musculoskeletal complaints might all be modified by the occurrence of regional pain. The presence of musculoskeletal symptoms could make a worker more aware of the physical demands of his or her job, and therefore more likely to report such activities. However, it seems less likely that the occurrence of musculoskeletal pain would increase people's propensity to report other somatic symptoms such as "nausea or upset stomach", "trouble getting your breath" and "hot or cold spells". Thus, the associations that were found with somatization are unlikely to be distorted by reverse causation. In support of this, somatization and other psychological factors have been found to predict the future incidence and persistence of musculoskeletal pain in longitudinal studies (5, 48, 49).

When these potential sources of bias are taken into account, it seems reasonable to conclude that somatization is a major determinant of multisite regional pain. The exact contribution of stressful physical activities and psychosocial aspects of work is more difficult to gauge but probably smaller. It is important to note that classification of a subject as having multisite pain in our study did not necessarily imply that pain occurred at several sites simultaneously, only that several anatomical sites were affected by pain at some time during the relevant time period (past year or month).

One novel aspect of our analysis was the use of the CART technique to identify subgroups of subjects with importantly differing risks, defined by combinations of risk factors. The findings from this analysis supported the view that within our study population, somatization was a major determinant of multisite pain. However, it is of interest that, within the subset of participants

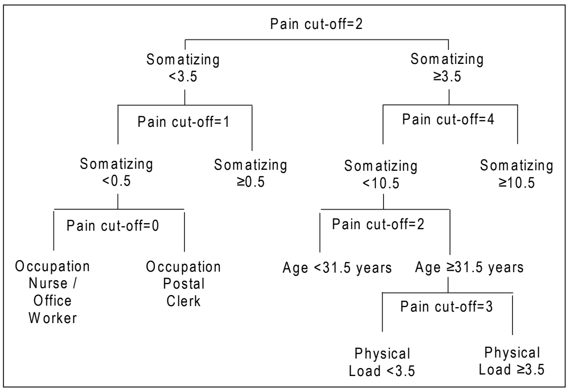

Figure 1. Classification tree (CART) for number of sites in pain during the past 12 months. For each split, the figure shows the risk factor (and its level) that discriminated between the two subsets of workers distinguished by the split, and a cut-off point in the number of sites of pain that characterized the distinction between the two subsets.

who were likely to have pain at <2 sites, discrimination between those with and without pain appeared to depend more on their occupation. It is possible that isolated pain at a single anatomical site is often a consequence of locally stressful physical activity, whereas somatization tends to generate a report of pain at multiple sites. This could be tested further in other data sets.

Concluding remarks

This study suggests that symptom rates were high in the three Greek occupational groups studied. Moreover, pain at multiple anatomical sites was more common than single-site pain. Our findings also indicated that somatization plays a particularly important role in multisite pain, with the possibility that the relative importance of psychological versus physical risk factors is different for widespread compared to localized pain. Future studies should explore the distinction between risk factors for musculoskeletal pain at multiple anatomical sites as compared with pain at only a single site.

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